

The Effects of Distraction on Performance in Schizophrenic, Psychoneurotic, and Normal Individuals

A DISSERTATION

Submitted to the Faculty of the Graduate School of Arts and Sciences of
The Catholic University of America in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

BY

EUGENE CHARLES STAMMEYER, B.A., M.A.



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and Normal Individuals

This dissertation was approved by Dr. Helen E. Peixotto, Associate Professor in Psychology, as director, and by Dr. Walter J. Smith and Dr. Allan F. Mirsky as readers.

THE CATHOLIC UNIVERSITY OF AMERICA

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INTRODUCTION

Ever since Emil Kraepelin (1919) first systematized the apparently unrelated syndromes of Morel (1860), Hecker (1871), and Kahlbaum (1864) into his classification of Dementia Praecox, numerous theories have been proposed to explain its etiology and pathogenic mechanisms. However, the nature of the pathogenesis of this disorder has, as yet, escaped recognition. Since clearly defined anatomical, physiological, biochemical, or metabolic changes have not been discovered, schizophrenia is generally considered to be a disorder of psychogenic origin. The conception of this psychosis which currently receives most universal acceptance is succinctly expressed in the Diagnostic and Statistical Manual of Mental Disorders published by the American Psychiatric Association (1952) where it is classified under "Disorders of Psychogenic Origin or Without Clearly Defined Physical Cause or Structural Change in the Brain."

Nevertheless, attempts to correlate organic pathology with schizophrenia have appeared throughout the history of the illness. Theorists in this area, although unable to present conclusive evidence to support their position, have nevertheless generated a great deal of research which has made significant contributions to the current state of knowledge concerning schizophrenia and has greatly influenced the management and treatment of schizophrenic patients. Many experimenters and clinicians remain confident that an organic basis for the disorder will eventually be demonstrated. Their hopes that a continuing search and improved research techniques will eventually prove the point are expressed by such authors as W. Grey Walter (1953), who

writes, "Willingness to ascribe mental difficulties and disorders to brain characters and diseases varies from generation to generation. There are physicians now living who remember the time when general paralysis of the insane was the commonest form of serious mental disorder, and was ascribed to the effects of excessive travelling, since it was most common among sailors, salesmen, and locomotive drivers. When it was shown to be due to the spirochaete of syphilis, prevention and cure became a matter of pharmacology and common sense. At the present time, many disorders that seem essentially mental are being attacked by physical means; there is less prejudice against this today than there has been for several hundred years."

Relatively recent progress made in the field of electroencephalography has provided an entirely new approach to the study of schizophrenia in terms of brain pathology. In 1949 a paper was published that has profoundly influenced the understanding of the electroencephalogram and opened a new line of investigation of brain and behavior relationships. These studies by Magoun and his fellow workers (Moruzzi and Magoun, 1949; Magoun, 1950; Magoun, 1952; Magoun, 1954) on the "Electrocortical Arousal Reaction" have provided an objective record of the role of afferent stimulation in evoking and maintaining both electrocortical and behavioral arousal. The experimental findings have consistently stressed the relationship between the reticular formation of the brain stem and attention, alerting, and activation. Samuels (1959) summarizes the implications of these experimental data in the following statement, "It would appear that the classical afferent systems transmit the information which forms the specific content of

consciousness, but do not per se mediate awareness. Rather, it is activity in the non-specific reticular system which provides the essential neurophysiological condition for the processes of perception, attention, and sensation."

There is considerable evidence for a disturbance in attentive behavior in schizophrenia. This is one of the primary symptoms of schizophrenia listed by Bleuler (1950). The question arises as to whether or not it is fruitful, therefore, to conceive of schizophrenia as an alteration in the functioning of the reticular formation. There is some experimental evidence to support this hypothesis.

Rubin and Turner (1942), utilizing electroencephalographic records, reported fewer slow-wave responses to hyperventilation among schizophrenics than among normals, and concluded that some condition exists in schizophrenia which is unfavorable for synchronization of low frequencies. They suggested that knowledge of the mechanisms involved in the appearance of slow waves in the electroencephalogram in hyperventilation should contribute to the understanding of the nature of schizophrenia. Liberson (1945) found a lower index of "alpha reductibility" in response to visual stimulation among catatonic schizophrenias than among psychoneurotics. Blum (1956) found that schizophrenic and brain-damaged patients show less change in alpha rhythm, either blocking or drive, than do normal subjects in response to photic stimulation. This author (Blum, 1957) reported another E.E.G. study which demonstrated that schizophrenics resemble brain-damaged patients, and differ significantly from normals, in their failure to show responsiveness of alpha-rhythm to visual, auditory and photic stimulation. Blum suggested that a disturbance in the retic-

ular activating system in schizophrenia could account for these findings.

Experimental evidence obtained from studies of reaction time also point up the impaired responsiveness of schizophrenic patients to external stimulation. In 1940 Rodnick and Shakow (1940) published results showing that normal persons responded with significantly shorter reaction times than did schizophrenics when a preparatory warning stimulus was given. Huston et al (Huston, Shakow, and Riggs, 1937) from a series of reaction time studies concluded that schizophrenic patients do not attain as high a level of preparation as normal subjects, that they vary more within themselves in the height of preparation attained from reaction to reaction, and that they do not maintain their level of preparation as consistently as the normal subjects.

In 1956 Lansing et al (Lansing, Schwartz, and Lindsley, 1956) published a paper relating reaction time to electroencephalogram activation with normal subjects, establishing the relation of behavioral alertness to the state of electrocortical patterns that serve as indices of "activation" via the reticular activating system. They studied reaction times under alerted and non-alerted conditions and found that reactions elicited under the alerted conditions were significantly shorter than under non-alerted conditions. Fedio (1959) replicated the Lansing study with schizophrenic population. The speed of reaction of the schizophrenic patients and the normal control group were not significantly different under non-alerted conditions, but only the normals improve with the alerting signal.

Rosenzweig (1955) published a theoretical formulation, documented by the experimental findings of others, suggesting that schizophrenia is a disorder involving midbrain structures including the reticular formation.

The results of these studies might be interpreted as reflecting some dysfunction in the activating or excitatory role of the reticular system in schizophrenia. An experiment by Hernandez-Peon and his co-workers (Hernandez-Peon, Scherrer, and Jouvet, 1956; Hernandez-Peon, Guzman-Flores, Alcaraz, and Fernandez-Guardiola, 1957) suggests a somewhat different, relatively unexplored approach which might prove useful in gathering further evidence relevant to this point. These workers studied the role of the reticular formation in the reduction of the influence of sensory stimulation when attention is directed to some compelling stimulus. They observed that when a cat's "attention" was focused on some particular object, visual and auditory evoked potentials were blocked. The attended object was favored by the selective exclusion of other incoming stimuli. The studies of these investigators point to the reticular system as the pathway by which this inhibitory or gating influence acts on afferent impulses.

Malmo (Malmo, 1957; Malmo, 1959) suggests that a central inhibitory mechanism may be weakened in all psychopathological disorders. He states further that this disorder may be conceived of almost entirely in terms of constitutional factors. He looks to the reticular system as being involved in this constitutional weakness.

Shakow (1950) cites an unpublished investigation of Rodnick which may be interpreted in terms of the relation of this inhibitory

function to schizophrenia. Rodnick observed that when distracting noises, lights, etc. were introduced into a pursuit meter learning situation, the normal subjects' learning curve was disturbed only during the "stress" trials. Neither the interspersed non-stress trials nor the post-stress trials were affected. However, in the schizophrenic the effect on the interspersed non-stress trials was about as much as on the stress trials, and the post-stress effect was even greater.

The present study investigates systematically the capacity of schizophrenic patients for sustained attention when extraneous stimuli are introduced into the test situation, utilizing the approach adopted by Rodnick in his preliminary observations. The work of Hernandez-Peon (Hernandez-Peon, Scherrer, and Jouvett, 1956; Hernandez-Peon, Guzman-Flores, Alcaraz, and Fernandez-Guardiola, 1957) suggests that acts of focal attention, which involve the exclusion of extraneous stimuli, are a function of the reticular formation in the brain stem. Therefore, if in schizophrenia there is a functional impairment of this system, schizophrenic patients should show inferior ability as compared with normal subjects and other non-psychotic, hospitalized, psychopathological groups on tasks requiring sustained attention or alertness when distracting stimuli are introduced.

A critical review of the classical literature in experimental studies of attention utilizing the "Single Task" or distraction method indicates that the deleterious effects of the distractors were generally most pronounced when the subjects were performing simple, routine, attentive tasks. The publications of Obersteiner (1879), Swift (1892-3),

and Evans (1916) demonstrate an increase in simple reaction time when distractions are introduced into the testing situation. On the other hand, the work of Tinker (1922), Hovey (1928), and Smith (1951) indicate that higher mental processes are comparatively unimpeded by distraction. Hovey (1928) found that intelligence is not related to susceptibility to distraction.

The overall results in this area are perhaps best expressed by the writings of Smith (1951) who concluded that the allegedly deleterious effects of extraneous stimuli are to be found primarily in depreciation of sustained performance rather than in short term mental performance.

In light of these findings, relatively simple, routine, monotonous tasks which require continuous attention from the subject over an appreciable interval of time were selected for this study.

One such test ideally suited for this study, in that previous investigations (Primac, Mirsky, and Roswold, 1957; Mirsky, Primac and Bates, 1959; Mirsky, Primac, Ajmone-Marsan, Roswold, and Stevens, 1960; Mirsky and Roswold, 1960) suggest that it may provide information as to alterations in the functioning of the reticular activating system, is the Continuous Performance Test (CPT).

A modification of the Digit Symbol Substitution Test (DSST), described by Wechsler (1958) as one of the oldest and best established of all psychological tests, and considered to reveal difficulties in concentration, was also employed.

In view of the experimenter-paced nature of the CPT as opposed to the DSST, which enables the subject to choose to a great extent his own time to respond and thereby permits a reorientation of attention between momentary lapses, it might be expected that the CPT would present a more sensitive measure of impairment in attentiveness than that provided by the DSST. Experimental evidence tends to confirm this assumption viz. that the two tests tap somewhat different mental functions.

The correlation between the two tests, although significant, is low ($r = .375$ to $.410$) (Mirsky and Roswold, 1960). The CPT also correlates less highly with the Full Scale I.Q. of the Wechsler-Bellevue, Form I ($r = .461$ to $.464$) than does the Digit Symbol Substitution Test ($r = .673$ to $.679$). Mirsky's (Primac, Mirsky, and Roswold, 1957; Mirsky, Primac, and Bates, 1959; Mirsky and Roswold, 1960) studies of the effects of various drugs on these two tests indicate that the DSST is more sensitive than the CPT to the action of agents which are considered to have their major effect on the cortex. On the other hand, the CPT is more sensitive to the effects of agents which are considered to act primarily on subcortical structures. He suggests that the DSST might thus be viewed primarily as a cognitive test. On the basis of the functions involved it could reasonably be classified as an Associative learning task. The CPT, on the other hand, may be viewed primarily as a test of alertness or vigilance.

If the study were to demonstrate that the hypothesized deficit of the schizophrenic patients is greater on the CPT than on the DSST, it would strengthen the interpretation of a malfunction of the reticular system.

METHOD AND PROCEDURE

Subjects - Three groups of 30 male subjects each, consisting of a schizophrenic, a psychoneurotic, and a normal group was studied. The two psychopathological groups were inpatients at Saint Elizabeths Hospital. The criteria for diagnosis of these two groups are based on the Diagnostic and Statistical Manual of Mental Disorders prepared by the Committee on Nomenclature and Statistics of the American Psychiatric Association (1952). The psychiatric diagnoses were determined from two sources, one being the preliminary evaluation and provisional diagnosis made by the psychiatrist in the admission suite, the other, the official hospital diagnosis, arrived at through an interdisciplinary medical staff conference. Only if these two sources agreed was the patient included in the study. None of the subjects had received tranquilizing drugs for a period of at least 30 days prior to testing. Six of the psychoneurotic subjects were on small daily doses of Meprobramate (300-900 mg.) but previous studies (Kornetsky, Humphries, and Evarts, 1957; Primac, Mirsky, and Roswold, 1957; Kornetsky and Humphries, 1958; Mirsky, Primac, and Bates, 1959) have shown that these dosages have no appreciable effect on the performance of the two tests utilized. There were no more than two such subjects in any one of the experimental groups. All of the patients had been at Saint Elizabeths Hospital for at least 30 days.

Only patients that were clinically relatively intact were selected for the initial screening. The rather gross criterion of intactness was based on the impressions of the ward physician. None of the schizophrenic patients exhibited obviously bizarre behavior at the time of the study. All of the patients had demon-

strated some capacity to assume responsible positions in patient groups and in carrying out hospital routines.

Patients who met these criteria were then administered the Wechsler Memory Scale, Form I; the Digit Symbol subtest of the Wechsler-Bellevue Intelligence Scale, Form II; and the AX task of the Continuous Performance Test for a period of 5 minutes.

The thirty schizophrenic patients who scored highest on these three measures were selected for the study. The diagnoses of this group were as follows: 11 Catatonic, 10 Paranoid, 6 Chronic-Undifferentiated, 1 Acute-Undifferentiated, 1 Schizoaffective, and 1 Simple.

Thirty diagnosed psychoneurotic patients were selected according to the same criteria and roughly matched as a group with the schizophrenic patients. The diagnoses of these subjects were as follows: 21 Obsessive-Compulsive, 5 Anxiety Reaction, 2 Depressive Reaction, 1 Dissociative Reaction, and 1 Conversion Reaction.

The normal subjects, roughly matched as a group with the schizophrenics, consisted of thirty enlisted Navy personnel stationed at a nearby base.

Setting of the Study The two patient groups were tested at Saint Elizabeths Hospital. All but five of the subjects in these two groups were tested in a partially sound-proofed room. Lighting was controlled with a variac so that the letters on the CPT were not visible to the subject except when illuminated by the bank of lights which operates with the equipment.

Five of the psychoneurotic subjects were confined in the maximum security division and because of security regulations could not be moved to the building in which the sound-proofed room was located. Testing of these patients was conducted in a room sufficiently isolated from other activities so that extraneous noises did not interfere with testing procedures. The lighting was regulated so as to be roughly equivalent to that of the sound-proofed room.

The normal subjects were tested at the naval installation at which they were stationed. The testing room was partially sound-proofed but it was not as quiet nor was the lighting as well controlled as in the testing rooms at Saint Elizabeths Hospital.

Tests The CPT consists essentially of a revolving drum on which two series of 31 letters each are mounted side by side. Only one series, that which serves the AX task, was employed in this study. The drum, enclosed in a boxlike case equipped with a visor through which the subject was required to look, made one revolution every 30 seconds. The letters were illuminated briefly one at a time. The lighting was provided by a bank of 0.5-watt neon bulbs mounted inside the case. The subject performed by depressing the response key whenever he saw an X follow immediately after the letter A. The letters came into view at approximately 0.92 sec. intervals. A response was scored correct if the key was pressed within 0.69 sec. after the brief illumination of the correct letter. Correct and incorrect responses were recorded automatically on a set of counters facing the back of the machine where the experimenter sat. There were six correct AX sequences in the 31 letter series. The subject's performance was

scored by dividing the number of correct responses during each revolution of the drum by the total number of correct responses possible.

The DSST was a modification of the Digit Symbol subtest employed in the Wechsler Intelligence Scales (Wechsler, 1958). The forms were constructed with seven rows of thirty boxes. The symbols of the Wechsler-Bellevue Intelligence Scale, Form II were used. The sheets were designed with markings which facilitated easy calculation by the examiner of the subject's progress as he worked. The subject's score, recorded every 30 seconds, consisted of the number of correct symbols executed during that time period. A stop watch was used to time the testing.

Distractors Cassell and Dallenbach (1918) and Smith (1951) concluded, from their own research and a review of the pertinent publications, that intermittent distractors are more resistant to habituation and are generally more deleterious to the performance of attention tasks than are continuous distractors. Since light and sound stimuli are the easiest to quantify objectively, intermittent distractions in these two modalities were employed in this study.

A transistor audio-oscillator producing a pure tone at a frequency of 1000 cps with an absolute intensity of 101 ± 2 decibels, triggered by a microswitch, presented sound distractions to a set of binaural earphones. The receivers were cased in rubber cups designed to fit tightly over the subject's ears. Tones of irregular duration (1 - 3.5 sec.) with variable intervals between them (0.1-1.5 sec.) were presented during the auditory distraction trials.

A Grass Photo-Stimulator with intensity dial setting at 16, flashing 5 times per second produced the visual distraction. This frequency was chosen on the basis of the work of Walter (1953), who reports, "Visual stimulation at the frequency of the Theta rhythm evokes, even in a normal subject, a feeling of annoyance and frustration." The lamp was placed at a distance of approximately 30 inches from the subject's head, in such a position that it flashed directly into his field of vision.

Design Each subject was tested under only one of the experimental conditions. After instructions the actual testing required approximately 15 minutes. One-half of the subjects (15) from each of the three groups (schizophrenic, psychoneurotic, and normal) was given the CPT. The other one-half was given the modified DSST. (The 45 subjects tested on the CPT shall be hereafter referred to as subgroup CPT and the 45 subjects tested on the DSST shall be referred to as subgroup DSST) The averages of each subgroup on the selection criteria relevant to the experimental test which they received are presented in Tables 1A and 1B.

The mean age of both the schizophrenic and psychoneurotic CPT groups was significantly higher than that of the normal group ($p < .001$). The mean Memory Quotient of the psychoneurotic CPT group was significantly higher than that of either the schizophrenic or the normal CPT groups ($p < .01$).

TABLE 1A

DESCRIPTION OF CPT SUBGROUP (N = 15 in Each Group)						
Group	Schiz.		Ne.		No.	
	Mean	SD	Mean	SD	Mean	SD
Age	32.87	5.37	34.40	3.34	24.93	5.15
Hosp. (In Mos)	36.60	57.42	14.67	15.62		
Educ.	12.13	3.54	11.87	2.79	12.33	0.62
Mem. Quot.	107.47	15.84	126.87	11.13	110.73	11.32
CPT	95.60	3.96	97.73	2.76	92.87	5.50

TABLE 1B

DESCRIPTION OF DSST SUBGROUP (N = 15 in Each Group)						
Group	Schiz.		Ne.		No.	
	Mean	SD	Mean	SD	Mean	SD
Age	33.13	7.82	32.13	6.87	27.17	8.26
Hosp. (In Mos)	37.07	48.51	17.93	15.77		
Educ.	12.93	1.87	12.53	3.11	12.40	1.40
Mem. Quot.	113.47	11.75	123.13	17.21	110.80	13.11
DSST	60.67	10.17	62.27	7.01	64.00	7.17

The mean Memory Quotient of the psychoneurotic DSST group was significantly higher than that of either the normal ($p < .02$) or the schizophrenic DSST ($p < .05$) groups.

Three different conditions of distraction were used: Light distractor, Sound distractor, and No-distractor. Five of the 15 subjects of each diagnostic classification in each subgroup (CPT and DSST) were tested under each of the distraction conditions. The number of subjects assigned to each experimental condition was the same for each of the subgroups and is shown in Table 2.

TABLE 2.

DISTRIBUTION OF SUBJECTS
IN VARIOUS EXPERIMENTAL CONDITIONS

	Light Distractor	Sound Distractor	No Distractor
Schizophrenics	5	5	5
Psychoneurotics	5	5	5
Normals	5	5	5

The 15 minute experimental testing session was divided into five 3-minute periods. The subject's score was recorded for each 30-second interval during testing. Thus, six scores were recorded for each 3-minute period. The periods were divided as shown in Table 3.

TABLE 3

DESCRIPTION OF PERIODS (Each number represents a 30-second interval)				
Period	Description of Period	Sequential Assignment of 30-Second Intervals		
1	Pre-Distr.	1-2-3-4-5-6		
2	Distr.	7- 9-10	-13-	-16-17*
3	Non- Distr.	-8-	-11-12	-14-15- -18*
4	Post- Distr. #1	19-20-21-22-23-24		
5	Post- Distr. #2	25-26-27-28-29-30		

(* The twelve 30-second intervals comprising Periods 2 and 3 were interspersed.)

Two 3-minute post-distraction periods were included in order to obtain sufficient data to study possible differences in rate of recovery from the effects of the distractors.

Once the testing of the subjects who were administered the CPT was begun, it was continued without interruption. However, the size of the DSST form, which must of necessity be limited in order to allow the subject to see continuously the key, was not sufficiently large to permit the same procedure for the subjects to

whom this test was administered. All subjects were stopped after the completion of Period 1 and given a new form to begin Period 2. If the subject filled this second form before the end of the six minutes required for Periods 2 and 3, time was stopped and a new form presented. All subjects were stopped after the completion of Period 3 and given a new form to begin Period 4. They continued without interruption through Period 5. However, if they filled this sheet before the time had expired, another form was presented.

RESULTS

Since there were significant differences between the groups on some of the selection variables reported in Tables 1A and 1B, the first step of the statistical analysis was to determine if any of these variables was significantly related to the susceptibility to distraction. Pearson Product Moment correlations (Walker, 1946) were computed separately for each of the two subgroups (CPT and DSST). The data for each of the characteristics presented in Tables 1A and 1B, with the exception of educational level, which showed little difference between any of the groups, were correlated with the difference in scores between Period 1 and Period 3. While Period 2 is the distraction period, the resulting loss of efficiency is most pronounced in Period 3, the interspersed non-distraction intervals. All groups appeared to show some drop in Period 3 (see Figure 4). Therefore, the difference in scores between Period 1 and Period 3 was considered to be a more sensitive measure of the effects of distraction than the difference in scores between Periods 1 and 2. The r s obtained from the computation of these correlations are presented in Table 4.

Since the scores provided by the two tests are not directly comparable, T-Score transformations (Walker, 1946) were calculated on all of the scores so that the results of the two tests could be combined into one analysis of variance. The results were then analyzed according to the sources indicated in Table 5.

TABLE 4

CORRELATIONS OF DESCRIPTIVE CHARACTERISTICS OF
EACH SUBGROUP WITH DIFFERENCES IN SCORES
BETWEEN PERIOD 1 AND PERIOD 3
(N = 45 in Each Subgroup)

Descriptive Characteristics of Subgroups	Subgroup CPT Correlation with Score Differences Between Periods 1 and 3 on CPT	Subgroup DSST Correlation with Score Differences Between Periods 1 and 3 on DSST
Age	-.09	+.13
Hosp.	-.21	-.06
Mem. Quot.	+.18	+.25
CPT	+.09	
DSST		+.21

None of these correlations reached statistical significance ($<.05$).

TABLE 5

ANALYSIS OF VARIANCE				
Source of Variance	Sum of Squares	DF	MS	F
Groups	5,027.96	2	2,513.98	19.8***
Tests	24.40	1	24.40	<1
Distr.	1,635.97	2	817.98	3.5*
L+S vs ND	1,635.93	1	1,635.93	7.06**
L vs S	.04	1	.04	<1
Periods	2,838.37	4(1)	709.59	39.0***
G X T	228.71	2	114.36	<1
G X D	3,206.92	4	801.73	3.46*
G X P	1,050.59	8(2)	131.32	7.2**
T X D	109.08	2	54.54	<1
T X P	925.43	4(1)	231.36	12.71***
D X P	776.41	8(2)	97.05	5.33**
G X T X D	953.00	4	238.25	1.03
G X T X P	297.29	8(2)	37.16	2.04
G X D X P	771.09	16(4)	48.19	2.65*
T X D X P	285.90	8(2)	35.74	1.96
G X T X D X P	224.65	16(4)	14.04	<1
Ss In Cells	16,691.15	72	231.82	
Ss In Cells X P	5,242.64	288(72)	18.20	
Total SS	40,289.56	449		

(Ultra-conservative F-tests, as described by Geisser and Greenhouse (1958), were employed. The numbers in parentheses indicate the degrees of freedom used in entering the F-table.)

*** P < .001

** P < .01

* P < .05

The results indicate that the distractors were effective in producing the desired effect. Orthogonal Contrasts (Edwards, 1950) applied to this source of variance indicate that the significant variance ($p < .05$) results from the difference between distraction and no distraction. The difference between light and sound was not statistically significant. The means obtained were Light = 48.4; Sound = 48.4; No Distraction = 52.5.

The highly significant variance due to the Periods ($p < .001$) is also to be explained in part by the effects of the distractions.

Individual Dunnett t Tests (1955) were computed for the difference in the means between Period 1 and the other four Periods. The Period means are presented in Table 6.

TABLE 6

MEAN SCORES FOR PERIODS	
Periods	Means
Period 1	49.2
Period 2	47.8
Period 3	46.6
Period 4	51.8
Period 5	53.4

The drop in means between Period 1 and Period 2 approached significance ($p = .055$) and the drop in Period 3 was significant ($p < .01$). On the other hand, the means of Period 4 and Period 5 were significantly higher than that of Period 1. ($p < .01$).

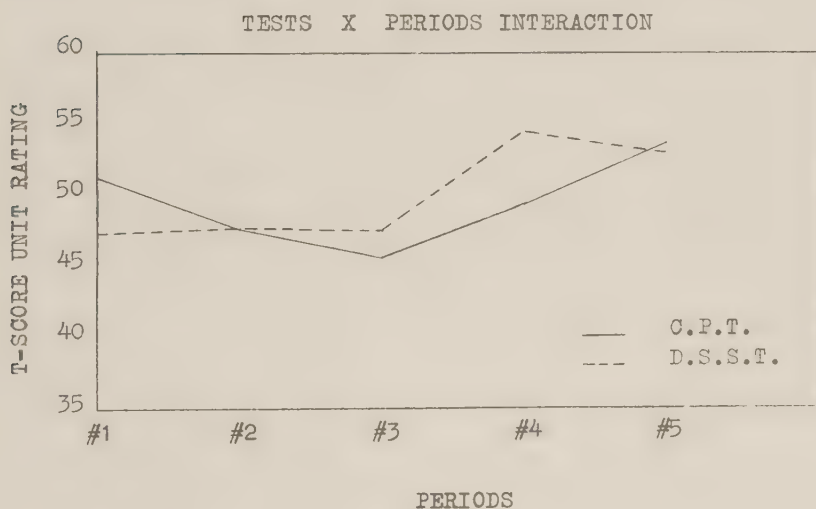
The variance due to the interaction of Distractors by Periods ($p < .01$), shown graphically in Figure 1, results from the deleterious effects of both sound and light distractions during Periods 2 and 3 as compared with the steady improvement in performance under no-distraction conditions.

FIGURE 1



The significant interaction between Tests by Periods ($p < .01$), graphically illustrated in Figure 2, was also further analyzed by computing Dunnett t tests on the differences between the means of Period 1 and following four Periods for each test. There was a significant drop in performance in both Periods 2 and 3 ($p < .01$) on the CPT but no significant change was found on the DSST during these Periods. Period 4 was not significantly different from Period 1 on the CPT but Period 4 was significantly higher than Period 1 on the DSST. Period 5 was significantly higher than Period 1 on both the CPT ($p < .05$) and on the DSST ($p < .01$).

FIGURE 2



That there were significant differences in the functioning of schizophrenic, psychoneurotic and normal subjects on the attention tasks when distractions were introduced is indicated by the F of 10.8 ($p < .001$) for Groups, and F of 3.46 ($p < .05$) for Groups by Distractors interaction, an F of 7.2 ($p < .01$) for Groups by Periods interaction, and an F of 2.65 ($p < .05$) for Groups by Distractors by Periods interaction. The first F ratio indicates that the three groups differ significantly in their overall performance on both tests. The other three reveal that they also differ in their reactions to the distractions. The variance due to tests and the Groups by Tests interaction were not significant.

To investigate further the sources of significant group variance, simultaneous orthogonal contrasts were made by first computing a complete analysis of variance on the data of the normal and psychoneurotic groups. The sums of squares from this analysis were then subtracted from those provided by the overall analysis of the three groups. The remaining sums of squares represent the variance accounted for by a contrast of the schizophrenic with the other two groups. The degrees of freedom of the overall analysis were thus partitioned in two. The results of these contrasts are shown in Table 7.

TABLE 7

SIMULTANEOUS ORTHOGONAL CONTRASTS FOR SOURCES
OF VARIANCE INVOLVING GROUPS

Normals vs Psychoneurotics				
Source of Variance	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	958.36	1	958.36	4.13
G X T	94.31	1	94.31	<1
G X D	375.12	2	187.56	<1
G X P	34.72	4(1)	8.68	<1
G X T X D	570.55	2	285.27	1.23
G X T X P	180.86	4(1)	45.27	2.48
G X D X P	72.91	8(2)	9.11	<1
G X T X D X P	111.61	8(2)	13.95	<1

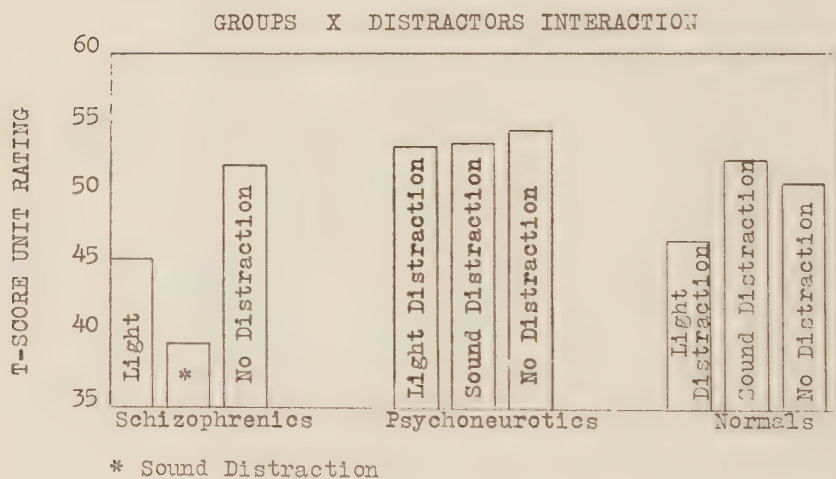
Schizophrenics vs Normals and Psychoneurotics				
Source of Variance	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	4,069.60	1	4,069.60	17.56
G X T	134.40	1	134.40	<1
G X D	2,831.80	2	1,415.90	6.11
G X P	1,015.87	4(1)	253.90	14.00
G X T X D	382.45	2	191.23	<1
G X T X P	116.43	4(1)	29.11	1.60
G X D X P	698.18	8(2)	87.27	4.80
G X T X D X P	113.04	8(2)	14.13	<1

Although the difference between the normal and psychoneurotic subjects was significant ($p < .05$), most of the total group variance (Table 2) was accounted for by the contrast of the schizophrenics with the other two groups ($p < .001$). The means of the schizophrenic, psychoneurotic, and normal groups were 45.5, 53.7, and 50.1 respectively.

Table 6 also indicates that the significant interactions of Groups by Distractors, Groups by Periods, and Groups by Distractors by Periods is accounted for by the contrast of the schizophrenic subjects with the other two groups.

Figure 3, the plot of the Groups by Distractors interaction, illustrates the greater impairment under distraction conditions of the schizophrenics as compared with the other two groups.

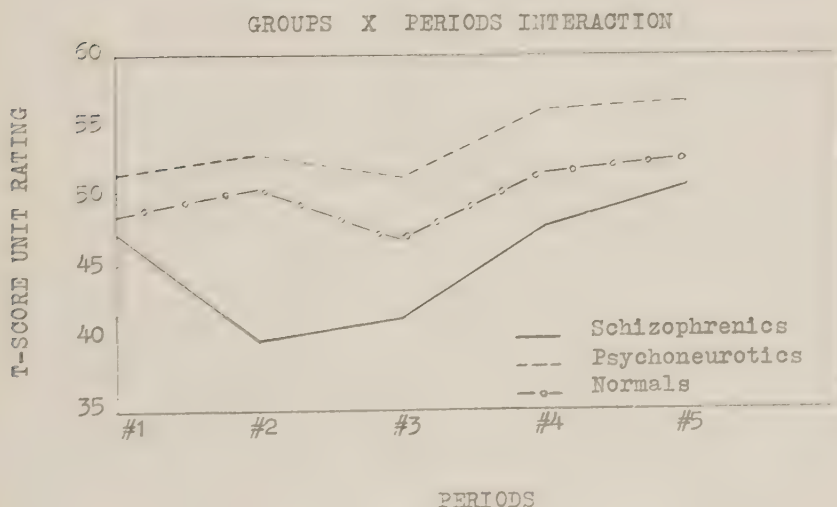
FIGURE 3



The Groups by Periods interaction, shown in Figure 4, illustrates the significantly greater impairment over time of the schizophrenic group as compared with the psychoneurotic and normal groups. Dunnett t Tests computed for the differences between the means of Period 1 and the following four Periods for

all of the groups indicated that there was no significant change in the performance of either the normals or psychoneurotics during Periods 2 and 3. Periods 4 and 5 showed a significant improvement over Period 1 for both groups ($p < .01$). The performance of the schizophrenic on the other hand, was significantly impaired in Period 2 ($p < .01$) and Period 3 ($p < .01$). Performance returned to the initial pre-distraction level during the first post-distraction period (Periods 1 and 4 are not significantly different). Only during Period 5 did the schizophrenics demonstrate significant improvement over their initial level ($p < .01$).

FIGURE 4



The Groups by Periods by Distractors interaction, graphically illustrated in Figures 5A, 5B, and 5C, demonstrates the same significant impairment under distraction conditions of the schizophrenics as compared with the other two groups. In order to illustrate these differences more clearly the means of the five Periods for all three groups under all three conditions of distraction were calculated in units of percentage-of-change scores. Period 1 scores were considered as equal to 100%. The percentage change from Period 1 was then computed for the following four Periods. The resulting graphs are shown in Figures 5A', 5B', and 5C'.

Figures 3 and 5C' indicate that the three groups did not differ significantly in the No-Distraction condition. Although the results did not reach statistical significance, an inspection of Figures 5A' and 5B' reveals opposite trends in Periods 2 and 3 for the schizophrenic group as compared with the other two groups. The performance of schizophrenics fell under distraction (Period 2) and improved a bit in the interspersed non-distractive intervals (Period 3). The normals and psychoneurotics, on the other hand, improved under distraction and became a bit worse during the interspersed non-distractive intervals. This was true for both light and sound distraction. Figure 5C' reveals the same trend for the normals even in the No-Distractive condition but here the schizophrenics and psychoneurotics showed a slight, although insignificant, improvement in both Periods 2 and 3.

FIGURE 5-A

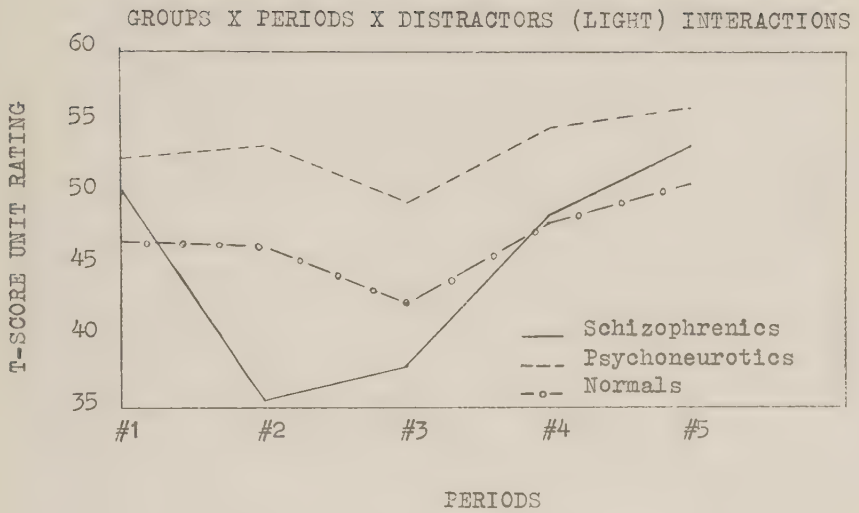


FIGURE 5A'

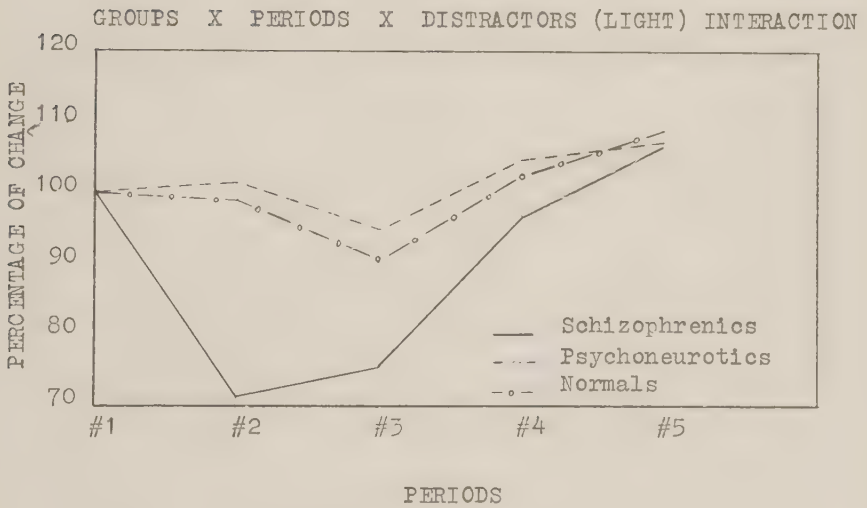


FIGURE 5-B

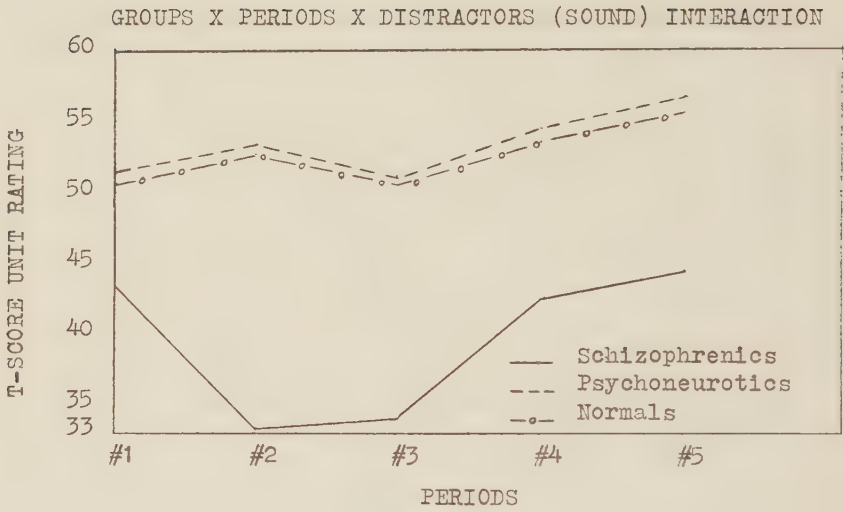


FIGURE 5B*

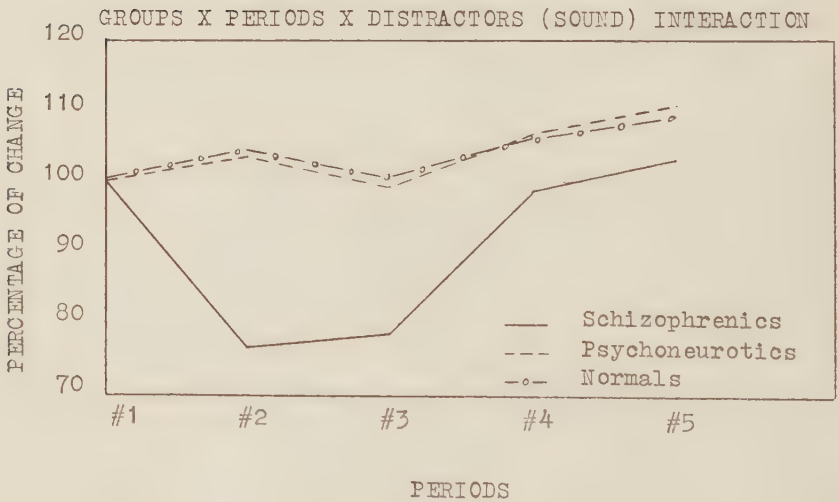


FIGURE 5C

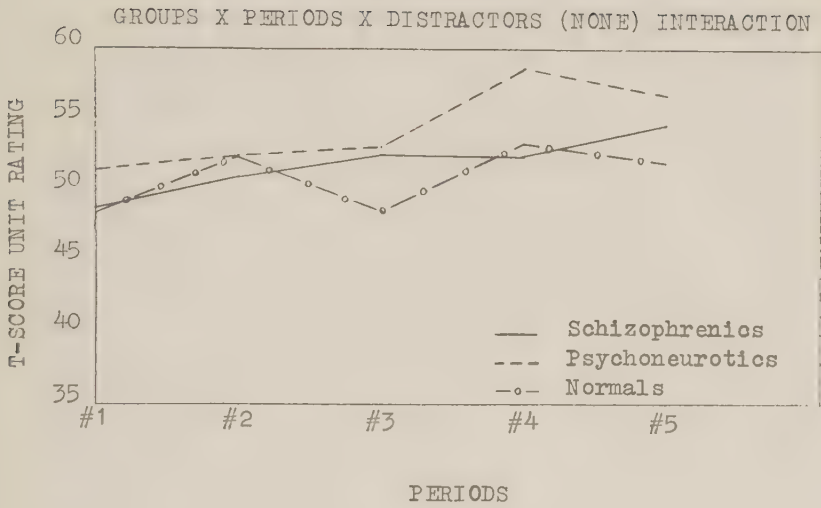
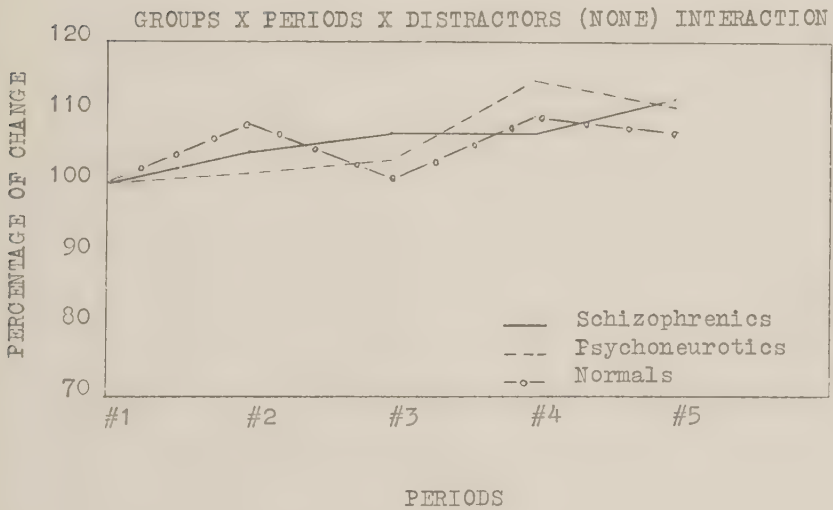


FIGURE 5C'



DISCUSSION

The comparisons in this study which attain statistical significance substantiate one of the major experimental hypotheses, that the performance of schizophrenic subjects on tasks measuring capacity for sustained attentiveness would show more impairment after the introduction of distracting stimuli than would the performance of normal and psychoneurotic subjects. Table 3 indicates that the majority of the variance due to groups was accounted for by the contrast between the schizophrenics and the other two groups. Figure 3 illustrates graphically that the significant Groups by Distractors interaction was accounted for by the greater impairment of schizophrenics under distraction conditions as compared with the other two groups. Figures 4, 5A' and 5B' indicate essentially the same pattern. Figures 3 and 5C' indicate that the three groups did not differ significantly in the No-Distraction condition.

The results of this study differ from the findings of Malmo (1957) who suggested that inhibitory mechanisms may be weakened in all psychopathological disorders. The overall superiority of the performance of the psychoneurotic over the normal group (Table 6) may perhaps be at least partially explained by the fact that the majority of patients in the psychoneurotic group (21 of 30) were Obsessive-Compulsives, a group which is characteristically driven to achievement (Schafer, 1948). In this connection, it may be noted that several of these patients commented after the testing was completed that they felt spurred to greater effort when the distractor was introduced. None of the normal or schizophrenic subjects

made such a comment. Also the fact that the room in which the normals were tested was not as quiet, nor the lighting as well controlled as in the room at Saint Elizabeths Hospital might have contributed to the difference between the overall performance between normals and psychoneurotics. However, the fact remains that the psychoneurotics functioned at least as efficiently as the normals. Indeed, the striking difference between the effects on the performance of the schizophrenics and the psychoneurotics suggests that the experimental approach utilized in this study deserves further investigation and may prove to be valuable in making differential diagnoses.

The confounding effects of learning in the performance of the DSST make it difficult to test the hypothesized greater sensitivity of the CPT to distraction. However, the results suggest that performance on these tests was affected differently over the expected periods. Figure 3 illustrates the tendency for all three groups to fall in performance on the vigilance task during the distraction period (Period 2) and the interspersed non-distraction period (Period 3). On the associative learning task, on the other hand, distractions apparently had less an effect, since the drop in performance was not significant. However, the failure to show improvement might represent effectively as great an impairment as the drop in CPT. Also on the vigilance task there was a gradual improvement in performance during the two post distraction periods, while on the associative learning task there was a more rapid improvement during the first 3 minute post-distraction period followed by a decay in performance during Period 5. This lowering of performance during Period 5 on the DSST may be due to fatigue, since the motor requirements of this task are more taxing to the subject than in the case of

the CPT. To make a more satisfactory study of the relative sensitivity of the two tests to the effects of distraction would require repeating the experiment after training the subjects to a stable asymptote of DSST performance before the experimental testing.

Analysis of the data in Table 6 suggests that there are probably two factors involved in the significant variance due to the Periods: the deleterious effects of the distractions in Periods 2 and 3; and a learning factor shown in the increased level of performance during Periods 4 and 5. The fact that the drop in performance during the distraction period (Period 2) does not quite reach statistical significance while the drop in performance during the interspersed non-distraction period (Period 3) is significant, tends to support the observations of Rodnick (Shakow, 1950) that studying the rate of recovery provides a more sensitive measure of the functioning of inhibitory mechanisms than studying the distraction trials directly. Duffy (1957) also suggests that the speed of recovery from arousal is one of the best indicators of neurotic and emotional unstable tendencies.

However, the results of this study are somewhat different from the preliminary observations of Rodnick in that, first, the performance of the normals and psychoneurotics was not significantly impaired during the distraction trials and secondly, the schizophrenic group in this study apparently improved more quickly in the post-distraction period than suggested by Shakow's remarks on Rodnick's findings.

Since the specific details of Rodnick's experimental findings were not published, it is impossible to compare the studies in detail.

However, it is noted that he employed a pursuit rotor task and perhaps, because this requires finer motor coordination than is required to execute the tasks in this study, his task is more complex. Also the stresses employed in Rodnick's study may be qualitatively different from the distractions used in this study.

Freeman and Rodnick's (1940) plea for conservatism in interpreting the deficit shown by schizophrenics is pertinent to this study. It is possible to explain the results by the relatively consistently demonstrated inability of the schizophrenic patients to maintain a mental set. However, in the light of the currently available and ever increasing evidence, it is not incompatible with this functional approach to consider impairment in the reticular formation of the brain stem as providing the physiological basis of this deficit. Hernandez-Peon's (Hernandez-Peon, Scherrer, Jouvett, 1956; Hernandez-Peon, Guzman-Flores, Alcaraz, and Fernandez-Guardiola, 1957) demonstrations of the influence of this system in blocking extraneous afferent stimulation in cats, while they were "attending" to visual stimuli, are especially pertinent. Thus, the results of this study are construed as supporting the interpretation that there is a deficit in the functioning of the reticular formation of the brain stem in schizophrenia.

SUMMARY

The present study was designed to examine the effects of distraction on an associative learning task and a vigilance task with schizophrenic, psychoneurotic, and normal individuals. A total of ninety subjects, with thirty in each group, were studied. The Digit Symbol Substitution Test (DSST) and the Continuous Performance Test (CPT) were employed. Three experimental distraction conditions were used: light distraction, sound distraction, and a control (no-distraction). A Grass Photo-Stimulator was employed for the light distraction and an audio-oscillator for the sound distraction. The fifteen minute experimental testing session was divided into five periods: pre-distraction, distraction, interspersed, non-distraction, and two post-distraction periods.

Analysis of the data revealed a significantly greater impairment in the performance of the schizophrenics as compared with the other two groups under distraction conditions. There were no significant differences among the three groups in the control condition and no difference between the light and sound distractions; both were equally effective in disrupting the performance of the schizophrenic group. The results suggest a somewhat greater sensitivity of the CPT than the DSST to the effects of distraction; although the influence of learning on the performance of the DSST makes this difficult to evaluate. Suggestions for further research to test this difference were offered.

The findings were compared with other studies where conflicting evidence regarding deficits in the performance of psychoneurotics

and schizophrenics were discussed. The findings were construed as supporting the interpretation that a deficit exists in the functioning of the reticular formation of the brain stem in schizophrenia.

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